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(54) **Flame-retardant cable**

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(73) Proprietor : **MITSUBISHI RAYON CO., LTD**
3-19, Kyobashi 2-chome
Chuo-ku
Tokyo (JP)

(72) Inventor : **Aoki, Kazunori, c/o Mitsubishi Rayon**
Co. Ltd.
3-19 Kyobashi 2-chome,
Chuo-ku
Tokyo (JP)
Inventor : **Yamamoto, Takara, c/o Toyama**
Plants
Mitsubishi Rayon Co. Ltd.,
3 Kaigandori
Toyama-shi, Toyama (JP)
Inventor : **Maeda, Eiji, c/o Toyama Plants**
Mitsubishi Rayon Co. Ltd.,
3 Kaigandori
Toyama-shi, Toyama (JP)

(74) Representative : **Jones, Helen Marjorie**
Meredith et al
Gill Jennings & Every,
Broadgate House,
7 Eldon Street
London EC2M 7LH (GB)

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Description

This invention relates to an optical fiber cable. More particularly, the present invention relates to a flame-retardant cable having an excellent flame retardancy and retaining a light-transmitting property of an optical fiber.

An inorganic glass optical fiber having an excellent light-transmitting property over a broad wavelength range is known and used as the conventional optical fiber, but the inorganic glass optical fiber is defective in that the processability is poor and the flexural stress is weak. In contrast, a plastic optical fiber has a higher pliability than the glass optical fiber, and has a high processability. Moreover, improvements in the plastic optical fiber-preparing technique have made the light-transmitting distance of the optical fiber long, and thus plastic optical fibers are now utilized as optical fibers for short-distance LAN and light information-transmitting members for various communications. Namely, the range of application for plastic optical fibers has been expanded.

When utilized in various fields, the plastic optical fiber is used in the form of a cable or cord fabricated by covering a single-core or multiple-core optical fiber with a protecting covering material (jacket material), or an optical fiber cable fabricated by combining a optical fiber yarn or an assembly thereof with a tension member or the like.

When a sheet formed by many plastic optical fibers joined in parallel is used, the sheet is covered with a protecting covering material (jacket material) and combined with a tension member or an electric wire.

Materials heretofore used as the protecting covering material for a plastic optical fibre are limited to polyvinyl chloride, polyethylene and the like.

Unlike nonflammable glass fibers, flammable plastic optical fibres are burnt, or dripping occurs when these fibers come into contact with a flame. When the conventional covering material is used, it is difficult to obtain a cable having an excellent flame retardancy from a plastic optical fiber. Moreover, even if a conventional flame-retardant material is used as the covering material, the flame-retardant component migrates into the optical fiber with a lapse of time, and thus the transparency of the fiber per se becomes poor.

EP-A-237440 relates to flame-retardant resins for covering telecommunication cables which may include fibre-optic elements. The covering materials are halogen-free polyolefin based polymers.

In EP-A-240875 a flame-retardant cable construction is described which may include glass optical fibres. A flame-retardant coating is provided using a fluorinated polymer. US 4575184 discusses the problem of loss of light transmission of optical fibres when fluorine resins are used to cover them and this reference discloses covering resins which are radiation cured copolymers of ethylene and vinyl acetate.

This invention has been completed under the above mentioned background, and a primary object of the present invention is to provide a flame-retardant cable having an excellent flame retardancy and wherein the fiber performances are not lowered with a lapse of time and dripping does not occur in the cable even if the cable comes into contact with a flame.

In accordance with the present invention, there is provided a flame-retardant single-core or multiple-core cable, which comprises a plastic optical fiber and at least one covering material covering the optical fiber, wherein at least one covering material is composed of a chlorinated polyethylene highly flame-retardant resin having an oxygen index (OI) of at least 32. Suitable examples are chlorinated polyethylene. Preferably the chlorinated polyethylene resin has an oxygen index (OI) of from 40 to 45.

In accordance with another aspect of the present invention, there is provided a flame-retardant single-core or multiple-core cable, as claimed in claim 3. The chlorinated polyethylene resin preferably has an oxygen index (OI) of from 40 to 45 and the highly fusible resin is chlorinated polyethylene preferably having an oxygen index (OI) of from 25 to 38, especially preferably chlorinated polyethylene having an oxygen index (OI) of from 27 to 35.

The following effect can be attained by the flame-retardant cable of the present invention.

(1) Since a highly flame-retardant resin having a large oxygen index is used as the covering material, the cable has an excellent flame retardancy.

(2) The use of chlorinated polyethylene produces a product in which the resin component does not migrate into the interior of the optical fiber even with a lapse of time, and therefore, the performance of the optical fiber are not lowered.

(3) When the cable comes into contact with a flame, dripping does not occur in the cable.

(4) Because of the mechanical characteristics of chlorinated polyethylene as the covering material, a good fitting property to a connector is given to the cable.

(5) When the cable comes into contact with a flame, the exposed optical fiber core is enveloped in the covering material of the inner layer and the flammable fiber is prevented from coming into direct contact with the flame, and therefore, a high flame resistance can be given to the cable.

One embodiment of the flame-retardant optical fiber cable 1 of the present invention is illustrated in Fig. 1.

The flame-retardant single-core plastic optical fiber cable 1 of this embodiment comprises one plastic optical fiber 2 and a covering material 3 bonded to this optical fiber.

The optical fiber used in the present invention is a plastic optical fiber, and as examples of the plastic optical fiber there can be mentioned a step index type multi-mode optical fiber comprising a cladding and a core, in which the refractive index is changed stepwise, a step index type single-mode optical fiber having a single mode, in which the refractive index is changed stepwise, and a graded index type multi-mode optical fiber in which different modes are transmitted. As the core-constituting material, there can be mentioned a polymethyl methacrylate resin (PMMA; homopolymers and copolymers of methyl methacrylate are included in the polymethyl methacrylate resin in the instant specification), deuterated PMMA, a polystyrene type polymer, a polycarbonate type polymer, poly-4-methylpentene-1 and a silicone type polymer. As the cladding material, a material having a refractive index lower than that of the core material, such as a fluorine type polymer, a vinylidene fluoride polymer or a perfluoroalkyl methacrylate polymer, or a methacrylic acid ester polymer, can be used.

At least one of the covering materials used in the present invention is a chlorinated polyethylene flame-resistant resin having an oxygen index (OI) of at least 32, preferably chlorinated polyethylene having an oxygen index of from 40 to 45.

Customarily used additives such as carbon black, other fillers, various reinforcers, flame-retardant agents and fire-resisting agents can be added to the covering material, so long as the object of this invention can be attained. As the flame-retardant agent, for example, there can be used tetrabromoethane, chlorinated paraffin, chlorinated polyethylene, tetrabromobisphenol A, hexachlorobenzene, perchlorocyclopentadecane, triethyl phosphate, tributyl phosphate, triphenyl phosphate, octyldiphenyl phosphate, bis(2,3-dibromopropyl) phosphate, tris(β -chloroethyl) phosphate, bis(2,3-dibromopropyl)-2,3-dichloropropyl phosphate, tris(2,3-dibromopropyl) phosphate, antimony trioxide, aluminum hydroxide, hexachloroendomethylene-tetrahydrophthalic acid, hexachloroendomethylene-tetrahydrophthalic anhydride, and mixtures of two or more thereof. Of these, antimony trioxide and aluminum hydroxide are especially preferred.

The flame-retardant cable of this invention is not limited to the above embodiment, and various modifications thereto can be made. For example, as shown in Fig. 2, the covering material can be combined with a tension member. As the means for arranging the tension member in the cable, a method can be adopted in which the tension member is interposed at the spinning or covering step and a covering layer is formed.

In the foregoing embodiment, a single-core cable comprising one optical fiber 2 covered with the covering material is illustrated. A two-core cable can be constructed by covering two optical fibers with the covering material 3, as shown in Fig. 3.

According to another embodiment of the present invention, there is provided a multiple-core electric wire/optical fiber composite cable 1 in which not only an optical fiber 2 but also a metallic electric wire core 5 is covered, as shown in Fig. 4.

According to still another embodiment of the present invention, there is provided a cable in which an optical fiber is coated and covered with not only a flame-retardant covering material but also a layer 8 of a functional covering material, as shown in Fig. 5.

One embodiment of the multi-layer flame-retardant plastic optical fiber cable according to the present invention is illustrated in Fig. 6.

The flame-retardant single-core plastic fiber cable 1 of this embodiment comprises one plastic optical fiber 2, an inner layer 6 of a covering material located on the side of the optical fiber core, and an outer layer 7 of a covering material.

The covering material of the outer layer 7 used in the present invention is a highly flame-retardant chlorinated polyethylene resin having an oxygen index (OI) of at least 32, preferably chlorinated polyethylene having an oxygen index of from 40 to 45.

The covering material of the inner layer 6 used in the present invention is a highly fusible resin which is wetted on the surface of the optical fiber when heated at a temperature higher than the softening point thereof, preferably chlorinated polyethylene having an oxygen index (OI) of from 25 through 38, especially preferably chlorinated polyethylene having an oxygen index (OI) of from 27 to 35.

The flame-retardant cable of the present invention is not limited to the foregoing embodiment, and various modifications thereto can be made. For example, the covering materials can be combined with a tension member 4, as in a modification shown in Fig. 7. As the means for arranging the tension member in the cable, a method can be adopted in which the tension member is interposed at the spinning or covering step and covering layers are then formed.

The cable of the foregoing embodiment is a single-core cable comprising one optical fiber 2 covered with a two-layer covering material. A modification can be adopted in which a two-core cable is constructed by cov-

erling two optical fibers with two covering materials 6 and 7, as shown in Fig. 8.

According to still another embodiment of the present invention, there is provided a multiple-core electric wire/optical fiber composite cable.

5 A further embodiment of the present invention is illustrated in Fig. 10. According to this embodiment, a plurality of optical fibers are placed in parallel in the form of a bundle, and this optical fiber bundle 2 is covered with a covering layer of a flame-retardant resin having an oxygen index (OI) of at least 32.

The preparation of the flame-retardant plastic optical fiber cable of this invention is accomplished, for example, by preparing an optical fiber having a core/sheath structure, and covering a predetermined covering material on this cable by using a cable covering machine to form a desired flame-retardant optical fiber cable.

10 When samples of the flame-retardant plastic optical fiber cable according to the present invention as shown in Table 1 below were evaluated, it was found that the samples passed the vertical flame test VW-1 according to UL-1060 of the UL (Underwriters Laboratories) Standards.

15 Table 1

Sample 1

20 Plastic optical fiber: PMMA (SK-40, Mitsubishi Rayon Co., Ltd.)
 ϕ 1.0 mm

25 Covering layer: Chlorinated polyethylene having an oxygen index of 34 to 35, layer thickness of 0.6 mm

30 Sample 2

Plastic optical fiber: PMMA (SK-40, Mitsubishi Rayon Co., Ltd.)
 ϕ 1.0 mm

35 Inner covering layer: Chlorinated polyethylene having an oxygen index of 28, layer thickness of 0.3 mm

40 Outer covering layer: Chlorinated polyethylene having an oxygen index of 44, layer thickness of 0.3 mm

50 **Claims**

- 55 1. A flame-retardant optical fibre cable (1) which comprises a plastic material optical fibre (2) and at least one covering material (3) covering the optical fibre, wherein the at least one covering material is composed of a chlorinated polyethylene flame-retardant resin having an oxygen index (OI) of at least 32.
2. A flame-retardant cable (1) as set forth in claim 1, wherein the flame-retardant resin has an oxygen index (OI) of from 40 to 45.

3. A flame-retardant cable which comprises a plastic optical fibre (2) and at least two covering materials covering the optical fibre in the lamellar form, wherein the covering material of the outer layer (7) is composed of a highly flame-retardant chlorinated polyethylene resin and the covering material of the inner layer (8) is composed of a highly fusible, chlorinated polyethylene resin which is wetted on the surface of the optical fibre (2) at a temperature higher than the softening point thereof.
5
4. A flame-retardant cable as set forth in claim 3, wherein the highly flame-retardant, chlorinated polyethylene resin has an oxygen index (OI) of at least 32, preferably from 40 to 45.
- 10 5. A flame-retardant cable as set forth in claim 3 or claim 4 wherein the highly fusible, chlorinated polyethylene resin has an oxygen index (OI) of from 25 to 36, preferably from 27 to 35.
6. A flame-retardant cable as set forth in any preceding claim, which is a single-core cable.
- 15 7. A flame-retardant cable as set forth in any preceding claim, which is a multiple-core cable.
8. A process of preparation of a flame-retardant plastic optical fibre according to any preceding claim using a cable covering machine to cover an optical fibre having a core/sheath structure, with the covering material.
- 20 9. Use of a chlorinated polyethylene flame-retardant resin having an oxygen index (OI) of at least 32 as a sheath (3) on a plastic optical fibre (2) to substantially prevent loss of transparency of the optical fibre over time.

25 Patentansprüche

1. Flammhemmendes optisches Faserkabel (1) mit einer optischen Faser (2) aus einem Kunststoffmaterial und mindestens einem Hüllmaterial (3), welches die optische Faser bedeckt, worin das mindestens eine Hüllmaterial aus einem chlorierten flammhemmenden Polyethylenharz mit einem Sauerstoffindex (OI) von mindestens 32 gebildet ist.
30
2. Flammhemmendes Kabel (1) nach Anspruch 1, worin das flammhemmende Harz einen Sauerstoffindex (OI) von 40 bis 45 besitzt.
- 35 3. Flammhemmendes Kabel mit einer optischen Faser (2) aus Kunststoff und mindestens zwei Hüllmaterialien, welche die optische Faser schichtförmig bedecken, worin das Hüllmaterial der äußeren Schicht (7) aus einem stark flammhemmenden chlorierten Polyethylenharz und das Hüllmaterial der inneren Schicht (6) aus einem hochschmelzenden, chlorierten Polyethylenharz, welches die Oberfläche der optischen Faser (2) bei einer Temperatur oberhalb des Erweichungspunkts benetzt, aufgebaut sind.
- 40 4. Flammhemmendes Kabel nach Anspruch 3, worin das stark flammhemmende, chlorierte Polyethylenharz einen Sauerstoffindex (OI) von mindestens 32, vorzugsweise von 40 bis 45, besitzt.
5. Flammhemmendes Kabel nach Anspruch 3 oder 4, worin das hochschmelzende, chlorierte Polyethylenharz einen Sauerstoffindex (OI) von 25 bis 36, vorzugsweise von 27 bis 35, besitzt.
45
6. Flammhemmendes Kabel nach einem der vorhergehenden Ansprüche, welches ein Einzelkernkabel ist.
7. Flammhemmendes Kabel nach einem der vorhergehenden Ansprüche, welches ein Mehrfachkernkabel ist.
- 50 8. Verfahren zur Herstellung eines flammhemmenden optischen Faserkabels nach einem der vorhergehenden Ansprüche, unter Anwendung einer Kabelhüllvorrichtung zur Bedeckung einer optischen Faser mit einer Kern/Mantel-Struktur mit dem Hüllmaterial.
- 55 9. Verwendung eines flammhemmenden chlorierten Polyethylenharzes mit einem Sauerstoffindex (OI) von mindestens 32 als Hülle (3) auf einer optischen Faser (2) aus Kunststoff zur weitgehenden Verhinderung des Transparenzverlusts der optischen Faser im Verlaufe der Zeit.

Revendications

1. Câble à fibre optique ignifuge (1) qui comprend une fibre optique en matériau plastique (2) et au moins un matériau de revêtement (3) recouvrant la fibre optique, dans lequel le matériau de revêtement, au moins unique, est composé d'une résine ignifuge de polyéthylène chloré ayant un indice d'oxygène (IO) d'au moins 32.
2. Câble ignifuge (1) selon la revendication 1, dans lequel la résine ignifuge a un indice d'oxygène (IO) compris entre 40 et 45.
3. Câble ignifuge qui comprend une fibre optique en plastique (2) et au moins deux matériaux de revêtement recouvrant la fibre optique en forme lamellaire, dans lequel le matériau de revêtement de la couche extérieure (7) est composé d'une résine de polyéthylène chloré hautement ignifuge et le matériau de revêtement de la couche intérieure (6) est composé d'une résine de polyéthylène chloré hautement fusible qui mouille la surface de la fibre optique (2) à une température supérieure à son point de ramollissement.
4. Câble ignifuge selon la revendication 3, dans lequel la résine de polyéthylène chloré hautement ignifuge a un indice d'oxygène (IO) d'au moins 32, de préférence compris entre 40 et 45.
5. Câble ignifuge selon la revendication 3 ou 4, dans lequel la résine de polyéthylène chloré hautement fusible a un indice d'oxygène (IO) compris entre 25 et 36, de préférence entre 27 et 35.
6. Câble ignifuge selon l'une quelconque des revendications précédentes, qui est un câble à âme simple.
7. Câble ignifuge selon l'une quelconque des revendications précédentes, qui est un câble à âmes multiples.
8. Procédé de préparation d'une fibre optique en plastique ignifuge selon l'une quelconque des revendications précédentes, utilisant une machine de revêtement de câble pour recouvrir une fibre optique présentant une structure âme/gaine avec le matériau de revêtement.
9. Utilisation d'une résine ignifuge de polyéthylène chloré ayant un indice d'oxygène (IO) d'au moins 32 comme gaine (3) sur une fibre optique en plastique (2) pour empêcher essentiellement la perte de transparence de la fibre optique dans le temps.

Fig. 1

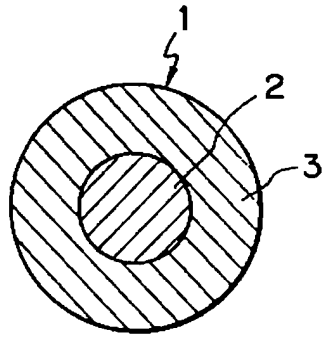


Fig. 2

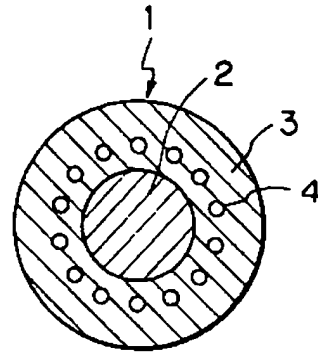


Fig. 3

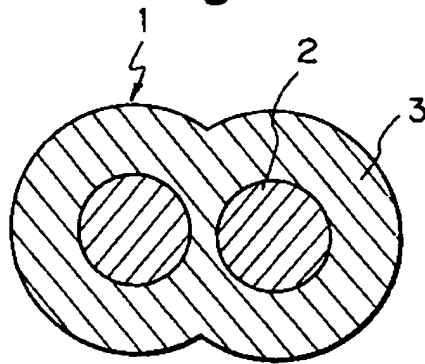


Fig. 4

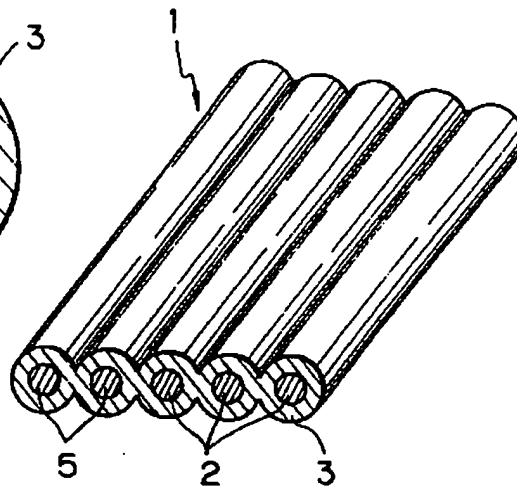


Fig. 5

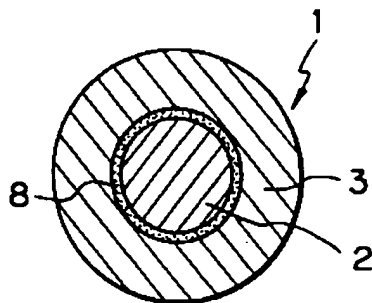


Fig. 6

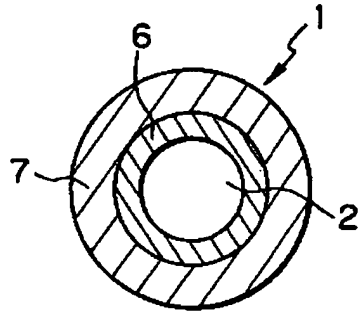


Fig. 7

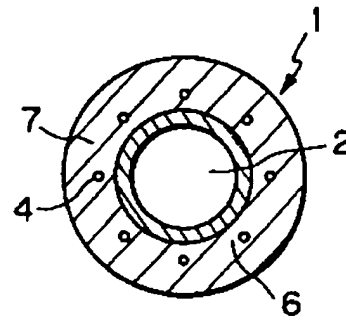


Fig. 8

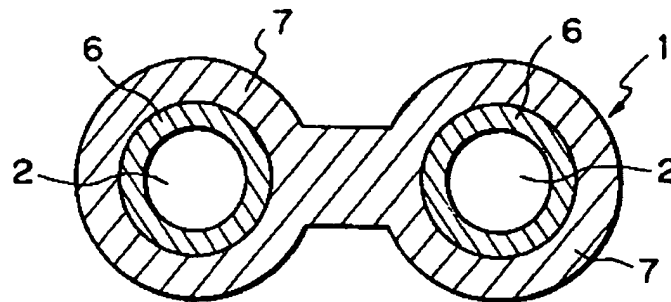
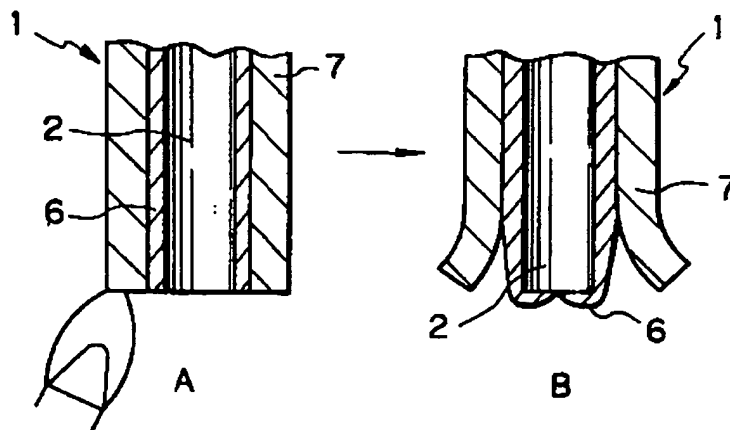


Fig. 9



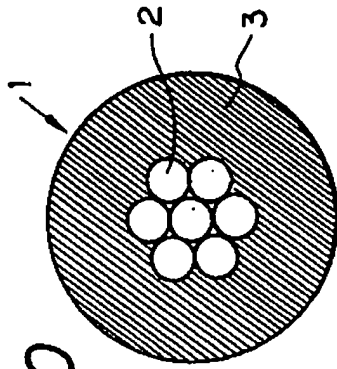


Fig. 10

Fig. 11

